AN ECONOMETRIC ANALYSIS OF COST CHANGES IN U.S. TRUCKING AND THE IMPLICATIONS OF IMPLEMENTING THE NAFTA TRUCKING PROVISIONS

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ABSTRACT

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The United States trucking industry underwent deregulation starting in 1980. There was much opposition to the process in fears that trucking companies would be adversely affected by increased competition. There were also many proponents and researchers who proved that the increased competition due to regulatory reform only helped strengthen the industry by forcing firms to become more cost efficient.

There has been similar opposition and support for the trucking provisions of NAFTA. Although the provisions have not been fully implemented, the trucking industry is well aware it will only be a matter of time. In early 2002 it was announced that the process to begin implementing the trucking provisions would begin in mid-2002. Many in the industry and other groups have opposed implementing the provisions, concerned that U.S. trucking firms would be subject to competition from Mexican firms, just as they feared trucking firms would be adversely affected by deregulation more than 25 years ago.

This thesis analyzes the effects the 2002 announcement of the process to begin implementing the trucking provisions has had on the cost structure of the industry. It uses a translog cost function to determine if firms have become more efficient in the years following the announcement in anticipation of increased competition from Mexican firms after the provisions are fully implemented. The translog cost function

is used to determine what effects the NAFTA variable has had on costs and what specific operating characteristics have caused the costs to increase or decrease.

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CHAPTER 1

STATEMENT OF PROBLEM

Introduction

The United States trucking industry has been impacted by many different factors over the last century. Changes in policy and regulations within the industry have had many effects on trucking firms, including changes in costs (wages, fuel, insurance, etc.), rates charged to customers, efficiency, and the general structure of the trucking industry, over the last 30 years. The most important change has been the process of regulation and the subsequent deregulation.

Regulation was brought about by the Motor Carrier Act of 1935. Many workers in the transportation industry lived in poverty and suffered poor working conditions. Wages tended to be low, and workers received little or no benefits; also, rates were unstable; services were often unreliable; and there was a high worker turnover rate. It was thought that regulation could rectify the situation by gaining more bargaining power for higher, more stable wages. The Interstate Commerce Commission (ICC) took control of regulation following the Motor Carrier Act (Henrickson 2004). Under this government control, strict rules were imposed on trucking companies to insure safety and prevent the negative effects of unregulated competition; rates were set; and entry into the industry by new firms was limited (Hircsh 1993). Following the enactment of the Motor Carrier Act of 1935, the International Brotherhood of Teamsters (IBT) was formed as the official union of the trucking industry (Peoples 1998).

Opponents of regulation claimed that the unionized and regulated trucking industry severely decreased competition and created a system of inefficient and inflationary union bargaining power (Ying 1990b). Many market economists blamed overall inflation, in part, on trucking and other regulated industries. On that basis, many urged Congress and the White House to deregulate many industries, including the trucking, airline, utilities, and telecommunications industries. The process of deregulation began in the late 1970's.

By 1977, the ICC began to let carriers work competitively as both common and contract carriers. New companies entering the industry no longer needed to prove they were necessary. By 1994, companies no longer had to file shipping rates and in 1996, the Interstate Commerce Commission was abolished. Drivers and trucking companies now found themselves in a competitive market (Tang and Ma 2002).

The Motor Carrier Act of 1980 made the process of deregulation official. Thousands of new carriers entered the for-hire industry sector and most were non-unionized and lower-cost. The new firms that began to take over were more efficient and innovative. According to the IBT, membership in trucking unions continued to decrease and by the year 2000, only 25 percent of all drivers were represented by a union. Deregulation also opened up new routes and introduced new suppliers, third-party transportation brokers, and freight forwarders (Hirsch 1993, Boyer 1997).

Problem Statement

The United States trucking industry has been further impacted in many ways by the North American Free Trade Agreement (NAFTA). The passage of NAFTA in 1993 http://www.bertholdfarmers.com/liberated trade between the United States,

Canada and Mexico. Provisions in the treaty stated that the border between the United States and Mexico was to be opened to U.S., Canadian, and Mexican trucking on December 17, 1995 (U.S. Department of Transportation). Since 1982, U.S. trucks have only been able to travel within about 20 miles of the Mexican border and Mexican trucks can only go about the same distance into the U.S. This is costly as truckers have to transfer goods from one truck to another to cross the border. Thus, proponents of the agreement felt these provisions to make crossing the border more efficient would benefit the trucking industry.

Opponents, however, argued against the terms of NAFTA. They argued that Mexican trucks were unsafe and unfit to travel within the United States because Mexican trucks didn't have to follow the same safety regulations as U.S. trucking companies. Many felt allowing them to travel across the border would compromise the safety of U.S. citizens. Many U.S. trucking firms also felt they would be subject to unfair competition since Mexican truckers work for lower wages. Many opponents argued this could cause U.S. trucker to lose jobs to Mexican truckers. Under this pressure the US government delayed the implementation of unlimited trucking access. Regulations were kept in place that allowed Mexican trucks within only 20 miles of the U.S. border and U.S. trucks within 20 miles of the Mexican border. In February of 2001, an arbitration panel ruled that the U.S. ban was in violation of NAFTA. Following the ruling, Congress approved and the President signed legislation detailing 22 safety requirements that must be met before allowing Mexican trucks to drive beyond U.S. commercial zones. In 2002, the U.S. Department of Transportation

certified these requirements had been met and announced that the process to begin implementing the NAFTA trucking provisions.

The proposed provisions of NAFTA would not allow Mexican drivers to carry goods between U.S. cities, only from Mexican cities to U.S. cities. However, this still creates competition for American drivers. Because Mexican drivers earn less than 20 percent of what U.S. drivers earn, American trucking companies can operate more cheaply using Mexican drivers. As U.S. trucking companies contemplate moving to Mexico, U.S. truck drivers may be affected.

Proponents of NAFTA claim that U.S. trucking companies will benefit by this free trade because it will reduce their costs and make them more efficient, and in return, reduce rates charged to their customers. Opponents claim U.S. trucking companies will suffer from reduced revenues because of competition from Mexican drivers and thus wages will decrease and rates to customers will increase.

Objectives

The main objectives of this study are to estimate the economic impacts that the announcement in 2002 to begin the process of implementing the trucking provisions of NAFTA has had on the United States trucking industry. The specific objectives are to

1. Determine the effects the NAFTA trucking provision implementation announcement has had on costs incurred by the trucking firms.
2. Determine what specific operating characteristics affect cost change.

Although there has not been much research done to analyze how trucking firms are reacting to the possibility of the trucking provision actually being implemented,

there has been a plethora of research done determining the effects deregulation had on firm's efficiency. Deregulation was also a monumental change for the trucking industry that many opposed for fear that increased competition would put firms out of business and lower paid non-union workers would take over jobs of union workers. Deregulation cause firms to change and become more efficient and cost saving. Thus, the basis of this paper is to determine if trucking firms are reacting to the possibility of increased competition in the same way firms reacted to deregulation.

The thesis is organized as follows: Chapter 2 provides a review of literature; Chapter 3 outlines the models used for this analysis; Chapter 4 summarizes the Data used for the modeling; Chapter 5 provides an analysis of the results of the research; and Chapter 6 summarizes the study.

CHAPTER 2

LITERATURE REVIEW

Introduction

The United States trucking industry has gone through many changes throughout its existence, including regulation; deregulation; and various policies that have affected competition and trade. Regulation and deregulation were controversial in the fact that the policies affected the union-nonunion wage gap, wages paid to drivers, costs, productivity, and efficiency of trucking firms. In recent years, the possible implementation of the NAFTA trucking provisions relating to the United States trucking industry renewed this controversy. Much debate has spawned, concerning the same issues regulatory reform brought about years ago as well as new issues. Some controversial issues included effects on drivers' wages, costs incurred by trucking firms, and safety concerns.

This literature review section gives a background of studies done on the effects of regulation and deregulation on driver's wages, union-nonunion density, costs, and efficiency. It also gives an overview of NAFTA and all the issues that go with the free trade agreement concerning the trucking industry.

Regulation of the Trucking Industry

Before 1935, the motor carrier industry was characterized by poor working conditions; rapid worker turnover rates; unstable rates; and unreliable services. Because of these factors and pressure and lobbying from the trucking and railroad firms; unions; state regulatory commissions; and the Interstate Commerce Commission (ICC), the Motor Carrier Act of 1935 was passed (Henrickson 2004).

The Motor Carrier Act of 1935 initially provided for regulation of the trucking industry and gave the ICC authority to the "for-hire" part of the trucking industry. The for-hire sector consists of drivers that define their industry of employment as trucking. Certain types of carriers were exempt from the restrictions including private carriers, the non-trucking companies that are limited to transporting only their own goods, and carriers of unprocessed agricultural products (Peoples 1998). Regulation severely restrained many areas of the trucking industry in order to keep competition low and prevent the existing trucking firms from being harmed economically (Hirsch 1993).

The issue of trucking regulation brought about much controversy related to increased profits and rates, and decreased competition and efficiency. Since the 1950s, economists have done studies indicating that U.S. motor carrier regulation has caused inefficiencies and a misallocation of resources. Reports have indicated that shippers have generally paid higher rates than needed and the costs of trucking firms have increased because of regulation. There is evidence that regulation caused over investment in equipment and impeded innovation, which led to decreased productivity growth. Also studies have found that union wage gains were anywhere between 37 percent and 55 percent more than competitive wages. Restrictions of regulation sometimes prevented carriers from completely filling their trucks, causing them to not utilize their capacity. The route restrictions added unnecessary miles to trips which added to costs, wasted resources, and slowed deliveries. Some restrictions also meant that some carriers returned from their destinations with empty trucks (Ying 1990b).

Rates for trucking companies or owner operators who could be hired to provide long-haul service for intercity and interstate carriage service were set. These set rates were often higher than the rates before regulation. The rate constraint as well as growth in the demand for trucking services and expansion of the United States highway system meant higher rents for firms in the trucking industry. The higher rents were the result of higher costs and prices than would have existed in a non-regulated, competitive industry. These higher rents were most often captured by the owners in the form of profit and workers in the form of wages (Hirsch 1993). Because the setting of detailed freight rates would have been extremely complex, the ICC encouraged regulated carriers to establish rate bureaus so that they could engage in joint ratemaking. These rate bureaus were exempted from antitrust laws after Congress passed the Reed-Bullwinkle Act in 1948. By 1980, there were ten major rate bureaus in existence and about 55 smaller rate bureaus (Hirsch 1993).

Entry into the trucking industry was also severely restricted. The ICC had authority to require common carriers to have designated points of origin and destination and had control over the routes over which they carried freight, and the types of freight. New route certificates were issued only where routes were not already being served and if entry would not economically damage existing carriers. Therefore, competition was severely limited as very few new trucking firms were allowed to enter the regulated sector (Hirsch 1993). However, defendants of regulation use statistics to argue that the ICC did not restrict entry into the industry. They pointed out the fact that the percentage of applications approved rose from 69.8 percent in 1976 to 99 percent in 1982 and that large numbers of applications were

filed each year. Critics argued that the ICC did limit new entry as new carriers were required to prove that current carriers were unable or unwilling to provide the service under consideration. As most major markets already received service, the new carriers had to serve very small, narrowly defined markets in order to enter the market (Putsay 1986).

Regulation that restricts the entry of competitors tends to allow for relative ease of unionization because the per-worker cost of organizing employees is low in industries consisting of only a few large firms. There is evidence that shows that this is what happened in the United States trucking industry after regulation (Peoples 1998).

Restrictions on entry and rate competition provided an opening for union gains in the trucking industry. As a result of regulation, membership in the trucking industry's union, the International Brotherhood of Teamsters (IBT), grew substantially. The IBT was formed in 1903 as a means of gaining better working conditions and wages for the teamsters. Teamsters in 1903 transported goods via horse and carriage. The union continued to grow and expand throughout the years until the beginning of the Depression. Membership hit an all-time low in 1933 with only 75,000 members. After the trucking industry was regulated in 1935, the IBT organized a large portion of the trucking industry. Membership grew from 75,000 in 1935 to 920,000 by 1948. The IBT's presence was most noticeable in intercity carriage, where the percentage of truckers belonging to the union grew from almost none in 1933 to nearly 80 percent by the mid-1940s (Peoples 1998 and IBT). The

IBT gained power and captured for union drivers a substantial share of industry rents (Hirsch 1993).

Regulation of the trucking industry also allowed another goal of the IBT to be realized. A long-time goal had been the signing of a national wage agreement to remove labor costs from competition among firms. The ICC rate setting restriction partially fulfilled this goal. The rate setting restriction allowed increases in wages (labor costs) to be largely passed on through rates. In some cases labor costs accounted for almost 65 percent of total freight costs. The rate-making through bureaus allowed regional and industry-wide wage increases to be passed on to shippers. Wage rates were no longer in competition. While trucking firms still had incentives to lower costs, the IBT's control of major terminals and their use of secondary boycotts until the 1960s allowed them to organize major segments of the trucking industry. Their major strength was in the regular route carriers of general freight in the less-than-truckload (LTL) sector of the market (Hirsch 1988).

In 1964 the National Master Freight Agreement was formed which shifted bargaining power from the regional to the national level. This allowed the IBT to gain national bargaining. However, competition arose in the 1970s partially due to natural economic responses to inefficiencies and cost differentials caused by regulation, as well as wage increases and increased legal restrictions on IBT's activities and power (Hirsch 1988). As a result of the increased competition, the ICC created a Motor Carrier Task Force to study problems with existing motor carrier regulations in 1977 (Tang and Ma 2002). In late 1978, the ICC allowed companies hauling their own goods to apply for authority to haul for others. They also abolished

regulations limiting contract carriers to service no more than eight shippers, expanded airport zones which were exempt from regulation, and announced that they would consider rates a factor in granting operation rights. By 1980, nonunion trucking firms not in the regulated sector had already increased their share of the market (Hirsh 1988).

Deregulation of the Trucking Industry

Deregulation processes began in the late 1970s with some policy changes. Policy changes in 1978 led to a record number of applications from new and existing trucking firms for routes (Peoples 1998). The Motor Carrier Act of 1980 deregulated the interstate trucking industry. The Act permitted free entry into the interstate industry and began to allow rate competition. Complete deregulation came about through legislations passed in 1982, 1986, 1993, and 1994. In August of 1994, congress passed the Trucking Industry Regulatory Reform Act (TIRRA), which eliminated all state oversight of intrastate trucking operations and removed rate filing requirements. Rates were now confidential and trucking firms could charge whatever they could negotiate with their customers. Also, motor carriers could carry what they wished anywhere in the United States (Tang and Ma 2002).

Deregulation had substantial impacts on the trucking industry. Interstate and intrastate deregulation allowed lower-cost and nonunion firms to enter the for-hire tucking industry sector. It also opened up new routes and introduced new suppliers, third-party transportation brokers, and freight forwarders. Shippers now had a larger choice of suppliers to choose from. Deregulation caused the bankruptcy of a majority of the twenty largest trucking firms. The process of deregulation also brought about a

higher rate of business failure among all trucking companies (Hirsch 1993). New firms took over that were more efficient and innovative (Boyer 1997). The entry of these new more cost-efficient, nonunion firms had major effects on the trucking industry. Some of these effects include: changes in union power and density, changes in trucking firms' costs, rates, and wages, and changes in trucking firms' efficiency, innovations, and profits.

Changes in Union Density After Deregulation

The new firms that entered the industry after deregulation were generally nonunionized and focused on cost minimization and efficiency. With the onset of price competition, nonunion carriers easily won business because of lower labor costs and more competitive rates. The availability of alternative low-cost carriers weakened the bargaining power of the IBT. Union density fell sharply following deregulation. Sixty-two percent of the for-hire truckers were unionized in 1973, this fell to about 30 percent in 1984 and down to 23 percent in 1996 (Engel 1998).

Various studies have been done to determine the effects on deregulation on union density. A study done by Hirsch in 1993 used Current Population Surveys (CPS) from the period of 1973-1990 to analyze changes in union density before and after regulation. He distinguishes between the for-hire sector (drivers who designate their industry of employment as the trucking service industry) and the private carrier sector (those drivers that define something other than trucking as their employment). This distinction is made because drivers in the for-hire sector were affected directly from deregulation while drivers in the private carrier sector were affected indirectly. He found that union density in the previously regulated for-hire sector fell from an

average of 60 percent during the regulatory period to about 40 percent by 1985 and down to 24 percent by 1990. Union density didn't decrease as much in the private carrier sector. Union density was at about 36 percent before regulation, it fell to 30 percent by 1985, and 25 percent by 1990. His study also found that there was relative growth in employment in the for-hire sector after deregulation. This could be attributed to the fact that during the regulatory period many companies did their own trucking rather than ship their products by regulated, more costly common carriers. After deregulation companies shifted to the more competitive for-hire sector.

Another study by Peoples (1998) summarized previous studies that have investigated the effects of deregulation on union density and wages in four sectors: trucking, railroad, airline, and telecommunications and compared them to a control group of workers in other industries. In this paper, data from 1973 to 1999 is used and was taken from Current Population Survey and Hirsch and Macpherson's Union Membership and Earnings Data Book. The period of 1978 to 1996 is considered the period of deregulation. His analysis shows that union membership in the trucking industry fell from 46 percent in 1978 to 23 percent in 1996. The union membership pattern is consistent with the notion that the trucking industry has low barriers to entry, thus deregulation allowed easy entry for nonunion firms. Union membership in the other three sectors also decreased. However, union membership in these four sectors is still higher than the national average for other industries. In 1996, only 14 percent of workers in the other industries belonged to a union.

Changes in Wages After Deregulation

Deregulation also brought about changes in wages in the trucking industry. The entry of new nonunion firms allowed more competition and thus lower rates and costs for trucking firms. The shift from regulation to deregulation meant shifting from rate regulation to competitive pricing. This made it unprofitable for carriers to pass on high union wages that are not justified by higher productivity. In the deregulated trucking industry, increased emphasis on cost minimization and declining control of the union's control over labor supply reduced the likelihood that the truck drivers would receive high wages. This effect may not have been limited to just unionized firms as nonunionized firms often increased their wages to compete with unionized firms in order to avoid workers rallying for membership in the IBT union (Peoples 1998). Various economic studies conducted have shown that trucking firm's costs, and thus wages have decreased since deregulation of the industry.[1]

Peoples (1998) analyzed the effects deregulation had on wages in four industries. He states that before deregulation, these four industries had strong unions that negotiated high wages for their members. These wages were at least 14 percent higher the wages received by workers in other industries. The rate regulations allowed by regulations allowed carriers in these industries to past on costs, including wages, to their customers which contributed to unionized workers receiving high wages.

Real weekly earnings in the trucking industry fell from $491 in 1978 to $353 in 1996, after the deregulation process. Earnings in the railroad industry fell from $491 to $470, earnings in the airline industry fell from $498 to $435, and weekly earnings

[1] These studies include Engel (1998), Hircsh (1993), and Peoples (1998).

in the telecommunication industry fell from $488 to $442. Wages in all other industries fell from $363 to $334. Trucking earnings fell 28 percent compared to earning decreases in any of the other industries which fell from 4 percent to 10 percent.

Peoples also investigated what happened to the earnings premium received by workers in the trucking industry after deregulation. Past research has indicated that for-hire truck drivers received an earnings premium that decreased after deregulation. Hirsch and Macpherson (1997) analyzed the effects that deregulation had on the union wage premium. Prior to deregulation, truck drivers also had an earnings premium compared to workers in other highly unionized industries. After deregulation, the earnings premium relative to other highly unionized industries disappeared and was even negative during some years. A smaller earnings premium relative to workers in industries not highly unionized remained. The wage premium for unionized truck drivers compared to workers in other industries in 1977-78 was 22 percent, this dropped to less than 2 percent by 1995. Management positions earnings premiums declined markedly in the trucking industry after deregulation. Before deregulation the premium was 13 percent, this fell to a minus 2 percent premium afterwards. Management position premiums in the other three highly unionized industries fell little. Of the four industries analyzed, the trucking industry experienced the largest decline in earnings premium. This indicates that the trucking industry seems to be the industry that has moved closest to full competition relative to its counterparts. This makes sense considering that the trucking industry has characteristics that satisfy

conditions for competition, including: low capital and entry costs to carriers and a labor supply that is elastic because workers skills can be acquired quickly.

A positive side to the declining per worker labor costs is that they are an important source of consumer welfare gains. Peoples (1998) calculated worker losses by taking the product of the earnings premium changes after deregulation and labor's total annual compensation in 1991. He found that worker's losses in current dollars of up to $5.7 billion in trucking, $1.2 billion in railroads, $3.4 billion in airlines, and $5.1 billion in telecommunications. Once again, the trucking industry saw the biggest decline. Peoples refers to a study done by Winston (1985) that calculated annual consumer welfare gains from deregulation of $50 billion for a not exactly comparable group of industries. This indicates that worker surplus losses represent a large share of consumer welfare gains from deregulation.

Hirsch (1993) analyzed the effects of deregulation on union density and wages. Using the CPS data for the years 1973-1990, Hirsch found that average real wage rates among union drivers in the for-hire sector declined after deregulation, but have shown slow change since the mid-1980s. Contrary to union truckers' wages, wages for nonunion for-hire drivers remained relatively stable during the entire 1973-1990 period. Union and nonunion workers in the private, unregulated sector saw very little change in their wage rates following deregulation. In the previously regulated for-hire sector, the union-nonunion wage differential fell from .39 during the regulatory period to about .30 after deregulation (in the late 1980s). Hirsch's findings (1993) mirror those of his 1988 study. Using CPS data from 1973-1985 Hirsch came to the same conclusions. He found that hourly earnings for union drivers fell after deregulation

while earnings changes for nonunion drivers followed the economy-wide changes among nonunion workers. He also concluded that the union-nonunion wage differential narrowed, but that the union premium remained large after deregulation. Hirsch discovered that truck drivers in the for-hire sector earned about 4 percent more than a control group of workers not employed in the trucking industry and drivers in the private sector earned about 4 percent less.

Engel (1998) also did research to analyze the effects that deregulation had on wages and union-nonunion wage premiums. She found that during the 1973-1978 period, real wages for unionized truck drivers averaged $12.45 per hour and fell to $11.15 during the 1979-1985 period. However, Engel's research showed that nonunionized truck drivers' wages changed very little between the two periods. This represents a narrowing of the union-nonunion wage premium. She estimated that the premium fell from a little less than 50 percent to 25-30 percent after deregulation.

Changes in Efficiency and Costs After Deregulation

More money is spent on trucking than any other form of transportation. Almost three times as much money is spent on intercity trucking as on railroad, water, and oil pipeline transportation combined. Estimates have calculated that it takes about one dollar per mile to drive a standard 18-wheel, 80,000-pound truck. Of this, about 40 cents go to the driver; 20 cents are spent on fuel; and the rest is spent on other costs, including depreciation, licensing, interest, tires, maintenance, and other items. Trucking firms pay for the use of highways in the form of fuel taxes. Some have argued that this amount is too low and does not compensate for the congestion, pollution, and safety problems that trucks cause on the highways, not to mention

general wear and tear on the roads. There are also more people employed in the trucking industry than in the other transportation industries. In 1994, there were roughly 1.84 million employed in the trucking industry; 240,000 in the railroad industry; 162,000 in water transport; and just 17,000 in oil pipeline transport (Boyer 1997). Efficiency and cost minimization are important in any industry; however, the sheer size of the trucking industry further exemplifies the need.

After deregulation, new firms were able to enter the industry. Many of those used sophisticated data management techniques to coordinate shipments to attempt to eliminate less-than-truckload (LTL) shipments and to ensure return loads. These improvements were important because they ensured that trucks were fully loaded and moving for as many hours as possible. The new data management tools as well as the development of a system of freight brokers helped increase efficiency. The new, more efficient firms were generally nonunionized, and the surviving unionized firms catered to the less-than-truckload sector (Boyer 1997). Lack of technology is a huge factor that causes inefficiencies. Firms may also be inefficient if they simply do not minimize costs due to protection of regulation, they face incentives for use of inputs, they suffer input biases due to required service levels or restrictions on purchases of inputs, or if the industry itself is inefficiently structured (Daughety and Nelson 1988).

Hubbard (1993) analyzed the effects of using such technological advances as on-board computers (OBCs) and electronic vehicle management systems (EVMS) in trucks. The results indicated that on-board computer use has increased capacity utilization significantly. In 1997, EVMS increased capacity utilization by 13 percent on adopting trucks. This implies that OBCs have enabled 3 percent higher capacity

utilization in the industry, which translates to billions of dollars of annual benefits. This increase appears to be mostly due to advanced capabilities that let dispatchers determine trucks' position in real time, and allow dispatchers and drivers to communicate while drivers are in their trucks. These capabilities enable dispatchers and drivers to keep trucks on the road and loaded more.

In a study done by Winston (1985), it was discovered that entry and exit regulations raised carrier costs substantially, and rate distortions cost society about $1 billion annually. Rate distortions were more serious in the less-than-truckload sector because they did not have the railroad alternative like the truckload sector did. It was expected that deregulation would decrease these inefficiencies. Adrangi, et al. (1995) used a profit function approach to investigate the issues of economies of scale and productive efficiency. He found that after deregulation, trucking firms changed their input mix in favor of labor, and firms became for technologically advanced. In the post-deregulation period, an increased in capital input precipitated a reduction in labor input approximately 21 times greater than in the pre-deregulation period. The study proves that deregulation seems to have restored technical efficiency in the industry.

Although, there is much evidence that deregulation increased efficiency in the trucking industry, there are studies that somewhat contradict this. McMullen and Lee (1999) analyzed data from 1976-1987 and found that average inefficiency in the motor carrier industry was between 14 percent and 27 percent for the entire period, with deregulation having no significant impact on efficiency. The lack of increased efficiency could be explained by a few reasons: the industry still has not adjusted to deregulation, continued union restrictions add to inefficiencies, and there are

limitations in the data set. They also found that prior to deregulation, union firms were 1.5 percent less efficient than non-union firms and 4 percent less efficient after deregulation.

Trucking firms also changed the quality and types of services they offered after deregulation. There was increased emphasis placed on efficiency. This was brought about by the adoption of just-in-time delivery systems and technology developments. Consumers benefited as firms strived to meet requirements for more reliable and frequent deliveries. This increased focus on efficiency reduced costs. The savings were passed on to consumers and businesses and have contributed to more competitively priced products. In fact, in 1996, the nation's freight bill hit an all times low. Shipping costs accounted for only 6 percent of GDP, down from 7.6 percent in 1980 (Engel 1998).

In a 1990 study, John Ying used a translog cost function to analyze direct and indirect effects of deregulation on trucking productivity. He used information from a sample of Class I and II common carriers of general freight because these firms often specialize in less-than-truckload shipments.[2] Ying used a sample of 61 firms from the years 1975-1984. A variety of operating characteristics were used in this analysis: average length of haul, percent LTL traffic, average shipment size, average cargo loss, and average load. In the time period before deregulation (1975-1979), there was little productivity growth. In the time period after deregulation (1980-1984), there were changes in costs and thus productivity. Cost savings in 1981 were small at about 1 percent, however, this increased to 23 percent in 1984. The characteristics that were

[2] Motor carriers of property are classified based on their adjusted annual operating revenue. Firms that have operating revenue greater than $10 million are classified as Class I, firms with revenue between $3-10 million are Class II, and those firms with revenues under $3 million are Class III.

statistically significant in bringing about reduced costs were: larger loads, a less valuable commodity mix, and a lower percentage of LTL traffic. Ying concluded that deregulation of the trucking industry forced firms to be more efficient, more aggressive, and to cut costs if they hoped to remain competitive.

Other studies have found similar results that deregulation reduced costs thereby increasing productivity and efficiency. Profit margins have not been above 3 percent since the early 1980s and are often less than 2 percent. This once again confirms that businesses served by trucking firms and consumers are benefiting. Contrary to what many thought might happen, larger trucking firms are not benefiting from deregulation at the expense of smaller firms. In fact, smaller firms increased their profitability more than larger trucking firms after deregulation. Deregulation made the industry competitive enough so that there is no existence of monopolistic profit enjoyed by large trucking firms (Tang and Ma 2002).

Other Effects of Deregulation

The primary implications of deregulation that are discussed and analyzed are usually the effects on wages, costs, and efficiency. However, some research has shown a few other effects.

Paid hours to both union and nonunion drivers decreased in the few years after deregulation. This could be due to the fact that nonunion workers are often paid not hourly, but on a mileage or freight basis. They are not paid for time they sit in traffic or during other down time (Engel 1998). Also, the average length of haul increased during the 1975-1985 period. This was due to the fact that deregulation allowed firms to expand geographically and allowed firms to serve more customers (Engel 1998).

Driver turnover has always been an issue in the trucking industry, but it worsened after deregulation. Increased workloads and lower pay were the two main factors that affected driver turnover rates. Labor turnover statistics estimated that labor turnover for large trucking firms in the truckload sector is between 80-100 percent. Smaller firms in the truckload sector had a turnover rate of 60-80 percent, and in the less-than-truckload sector turnover rates were much lower at around 15 percent. The total labor turnover rate for all types of firms was estimated at 38 percent (Engel 1998).

All of the above studies mentioned reach the same conclusion. Under regulation, firms did not focus on cost minimization and thus were not efficient or as productive as they could be. After deregulation, firms had to minimize costs and offered more customer oriented services in order to stay competitive. Shippers and consumers benefited from the reduced costs while the truck drivers suffered as a result of lower wages.

NAFTA

Prior to 1982, both Canadian and Mexico-domiciled motor carriers could apply for authority to operate within the U.S by filling out an application with the ICC. The U.S. did not make distinctions between domestic and foreign firms when deciding whether or not to give operating authority. However, this ended with the Bus Regulatory Reform Act of 1982. The Act was developed in response to complaints that Canada and Mexico were not allowing the same access of U.S. carriers into their countries as the U.S. was allowing them. Under the Act, Congress imposed a two-year moratorium on the issuance of new grants of U.S. operating authority to motor

carriers of a foreign country. The legislation authorized the President to remove or modify the moratorium if he determined it to be in the interest of the nation. The moratorium was quickly lifted on Canada as issues were resolved, but not for Mexico because they did not lift restrictions on market access for U.S. firms (U.S. Department of Transportation, FMCSA).

Certain firms were exempt from the moratorium including Mexican firms transporting goods straight to Canada, firms that had acquired operating authority prior to 1982 (this included only five Mexican carriers), and U.S.-owned Mexican-domiciled truck companies (about 160 companies). The Mexican-domiciled firms that were not exempt from the moratorium were restricted to operating in a commercial zone that extended only three to twenty miles past the U.S. border. In order to operate in the commercial zone Mexican carriers had to obtain a Certificate of Registration from the Federal Motor Carrier Safety Administration (Condon and Sindha 2001). Similarly, U.S. trucks could not go more than three to twenty miles past the Mexican border. Because of these restrictions, trucking goods from the U.S. to Mexico and vice versa became time consuming, inefficient, and costly (Moore 2004). The inefficiencies at the border provided evidence that something needed to be done to rectify the situation. Provisions of NAFTA that pertained to the trucking industry were intended to do just that.

The North American Free Trade Agreement (NAFTA) was ratified by the U.S. Congress in late 1993 and implemented on January 1, 1994. The trade agreement was designed to promote free trade among the U.S., Mexico, and Canada. The free trade agreement inevitably meant that trade flows between all three countries would

increase. In fact, from 1993 to 2000, there was a fourfold increase in two-way trade between the U.S. and Mexico. Since about 85 percent of the products traded between the U.S. and Mexico moves by truck and there are about four million border crossings annually, provisions of NAFTA were written to end the inefficient border procedures in the trucking industry (Moore 2004).

Considering that Mexico is one of the U.S.'s largest trading partners, many determined that provisions to NAFTA to reduce these inefficiencies at the border were needed. The terms of NAFTA provided that the U.S. would lift the moratorium on Mexico-domiciled trucking firms. On January 1, 1994, the president modified the moratorium and the ICC began accepting applications from Mexico-domiciled passenger carriers to conduct international charter and tour bus operations in the U.S. Starting in December of 1995, Mexican and U.S. carriers were to be allowed to serve the border states of the other country. In the U.S., these border states were Arizona, California, New Mexico, and Texas. By January 1, 2000, trucks from both countries would be able to operate freely in each other's country. By the end of 1995, U.S. and Canadian firms would be able to acquire minority ownership in Mexican tucking companies providing international cargo services, they could have 51 percent ownership by 2001, and 100 percent ownership by 2004. However, in December of 1995 the U.S. stated that it would delay implementation of the NAFTA trucking provisions because of pressure from the IBT; safety concerns from environmental and consumer safety groups; and political pressure (U.S. Department of Transportation, FMCSA).

On September 22, 1998 Mexico initiated arbitral proceedings under NAFTA Chapter 20 claiming that the U.S. violated NAFTA by failing to phase out the restrictions on cross-border trucking. The U.S. continued to argue that the provisions were not being implemented because of safety concerns (The American Society of International Law 2003).

Regardless of the arguments, a NAFTA panel determined that the U.S. restrictions were a breach of its NAFTA obligations. They did state, however, that the U.S. did not have to allow access for all Mexican trucking firms without regard to safety or other concerns, but could review applications from Mexican operators on a case-by-case basis. During his 2000 presidential campaign, President Bush stated that the U.S. should honor its NAFTA commitments regarding cross border trucking. He commited to Mexico's President Vicente Fox that the U.S. would fully open the border to international trucking.

In 2002 Congress passed legislation that required a program to be established for inspecting, certifying, and verifying Mexican carriers to be safe and insure for operation in the U.S. Concerns regarding safety, compliance, and monitoring of Mexican commercial vehicles were resolved in the Transportation and Related Agencies Appropriations Act of 2002 (U.S. Department of Transportation, FMCSA). The Act allowed Mexican trucking firms to apply for authority to operate within the commercial zone along the border, or they were allowed to apply for authority to operate beyond the commercial zone to their final destinations. The Mexican trucking firms, their vehicles, and their drivers operating within the U.S. are subject to all of the Federal Motor Carrier Safety Administration's safety requirements, inspection

procedures, enforcement mechanisms, fines, and out-of-service orders. They are also subject to various safety audits, compliance reviews, and roadside vehicle inspections (U.S. Department of Transportation).

Some activist groups filed petitions in U.S. federal court alleging that the regulations violated the National Environmental Policy Act (NEPA) and the Clean Air Act (CAA). The court ruled in their favor stating that they agreed with the importance of the U.S.'s compliance with its treaty obligations, but that the compliance cannot come at the cost of violating U.S. law (The American Journal of International Law, 2003). Delaying the implementation of the NAFTA trucking provisions have raised prices in the U.S. and discouraged the trucking industry in Mexico. On June 7, 2004, after years of arguments, the U.S. Supreme Court ruled in favor of opening up cross-border trucking. Even after the ruling, border crossing is still time consuming because of administrative and legal requirements (Moore 2004).

The trucking provisions of NAFTA are still hotly debated. The main reason given for opposition has consistently been safety. Mexican trucking regulations on safety are very different from those in the U.S. and their industry is much different from the U.S. industry. Mexico's regulatory truck safety system is not as sophisticated as the U.S. and is inadequate to ensure that Mexican trucks entering the U.S. can meet the safety standards (U.S. House of Representatives 2001).

Mexican trucks are often much older than U.S. trucks (the average Mexican truck is 15.5 years old and the average U.S. truck is only 5.5 years old), and don't meet the U.S. safety standards (Kornis 2000). In 1998, the Department of Transportation reported that 44 percent of Mexican trucks do not meet safety

standards, compared to 27 percent of U.S. trucks. Safety standard failure rates varied among the border states. Twenty-eight percent of the Mexican-domiciled trucks inspected in California failed safety inspections, 42 percent in Arizona, 37 percent in New Mexico, and 50 percent in Texas. The Federal Motor Carrier Safety Administration reported that in 2000, 36 percent of Mexico-domiciled trucks inspected at the border had a safety problem that required the trucks to be removed from service. The rate observed for U.S. trucks was 24 percent.

Numerous safety standards differ between the U.S. and Mexico. Mexican regulations allow much longer trucks than most states in the U.S. do (Boyer 1997). The U.S. limits truck weights to 80,000 pounds, compared to Mexico's 97,000; the U.S. requires front-wheel brakes, and Mexico does not. Furthermore, Mexico does not require the maintenance of driving logs or other types of data that would be needed for enforcement (Condon and Sinha 2001).

In reports issued in December 1998, November 1999, and May 2001, the DOT Inspector General stated finding that too few Mexican trucks are being inspected at the border, too few comply with U.S. safety regulations, and the U.S. does not have a consistent enforcement program that provides reasonable assurance of the safety of Mexican trucks entering the U.S. The reports cited lack of inspectors, lack of inspection facilities, lack of databases, and lack of enforcement as a cause for the high safety inspection failures. The same report also found that 254 Mexico-domiciled motor-carriers were operating illegally beyond the commercial zones in 24 states in 1998. (U.S. House of Representatives 2001).

Studies have shown that the presence of a comprehensive and adequate inspection facility will lower the failure rates. Truckers are more inclined to adhere to safety standards if they know they are going to be inspected thoroughly. The border at Otay Mesa, California has a comprehensive inspection facility with trained inspectors and the failure rate for both U.S. and Mexico trucks was the same at 24 percent. Areas that have inadequate inspection facilities have failure rates as high as 60 percent (U.S. House of Representatives 2001).

Although there is overwhelming evidence that Mexican-domiciled trucks are a safety concern, many promoters of the provisions of NAFTA argued that the safety issues may not be as serious as they seem.

Mexico has stated that because border crossing is so time consuming and requires modifications to trucks to meet safety standards, only the newest and best trucks are used to transport goods across the border. Mexican safety standards differ from the U.S. safety standards in areas, including the fact that they allow heavier trucks and don't restrict the number of consecutive hours drivers can work. This is a major safety concern, however, Canadian truckers have full access to the U.S. even though their safety standards allow for trucks that are 60 percent heavier than U.S. trucks and allow drivers to log 30 percent more consecutive driving hours than U.S. drivers (Schneider 2000). This is somewhat contradictory to the safety concerns given for not allowing Mexican trucks free access to the U.S.

A study done by Moore (2004) stated that about 90 percent of Mexican truck drivers have only one truck, no insurance and no desire to travel to the U.S. where they don't know the language. Only the more modern and safer trucks are used for

long haul trips. According to the U.S. Department of Transportation, the failure rate of Mexican trucks in California was 27 percent in 2000, this is just over the U.S. failure rate of 24 percent.

Some proponents believe the safety concerns are a cover up to avoid competition from lower-paying Mexican firms. Boyer (1997) states that while Mexican firms do pay their drivers lower wages than U.S. firms, the U.S. firms will not face stiff competition because the Mexican firms cannot match the U.S. firms' productivity and efficiency. Also, the Mexican Trucking Association has advocated for continued delays for the trucking provisions of NAFTA. They are concerned that the Mexican firms are not ready to compete with U.S. and Canadian firms and they need more time to modernize their fleets. They are also well aware that Mexican safety regulations are not very similar to U.S. safety standards (Schneider 2000).

The U.S. fleet is much larger than the Mexican fleet. In 2002, there were about 500,000 trucking companies in the U.S., compared to only 8,000 in Mexico. Of those 8,000 firms in Mexico, only about 2,000 go beyond regional, owner-operated concerns. The 8,000 firms represent about 410,000 units, of which 160,000 are Class A trucks, and the U.S. has 2.8 million Class A trucks (Eisenhart 2002).[3] It is obvious that the U.S. has a size advantage over Mexico.

In a report done in the winter of 2001, the General Accounting Office (GAO) predicted that few Mexican firms would immediately begin sending trucks into the U.S. They gave several factors for this belief; the Mexican firms would have difficulties finding affordable insurance, there would be a lack of business

[3] Class A trucks are defined as trucks or truck combinations weighing with a Gross Vehicle Weight Rating of 26,001 lbs. or more, provided towed vehicle is more than 10,000 lbs.

relationships beyond the commercial zones, which may cause empty return trips, border congestion could affect profitability, and costly registration fees (Eisenhart 2002).

There are 27 ports of entry along the U.S.-Mexico border that process border crossings, however only seven of those carry 91 percent of the cross-border traffic. Texas has 15, Arizona has six, California has four and New Mexico has two. Of those, the ports at Laredo and Otay Mesa are by far the busiest. They average roughly 2,500 commercial vehicles per day (Schneider 2000).

Haralambides, Londono-Kent (2002) analyzed the inefficiencies at the border and the extra costs associated from those inefficiencies. In their analysis, they outlined a hypothetical shipment from Chicago, IL, USA to Monterrey, Mexico. The border crossing they chose was the Laredo border crossing because it is the largest border crossing between the U.S. and Mexico. This border accounts for 40 percent of trade by volume and 50 percent of trade by value. They determined that moving the shipment takes a total of ten movements, a minimum of three different trucks, and various pieces of equipment for loading and unloading. The total time to move the shipment from the U.S. to Mexico takes an average of 32 hours if there is a team of drivers and about 48 hours if a driver is working alone. Total costs range from $1,813 to $2,189.

The costs and the amount of time it takes to get the load from Chicago to Laredo are the result of: trucking from Chicago to Laredo, handling costs and associated times of Mexican broker inspections for pre-clearance and storage, costs of loading and unloading, drayage costs and times of border crossings, inspections on the U.S.

and Mexican sides, and trucking from Nuevo Laredo to Monterrey. It was determined that it takes longer to travel a few miles near the border than it does to travel from Chicago to Laredo. Reducing the time and costs associated with moving goods between the two countries may reduce the costs of the final goods. In fact a study completed by Jamieson and Harrison (2002) looked at the effects of free trade on prices. In their study, they analyzed the effects that free trade would have on Texas and Mexico, and determined that a border free of tariff and non-tariff trade barriers would decrease prices on goods traded between Texas and Mexico, which would increase trade. They also found that an open border should lead to reduced congestion, reduced accidents, and less pollution (air and noise) for Texas border communities.

The inefficiencies described in the previous study are the cause of legal and institutional barriers and procedures imposed and tolerated by the two countries. Some examples of these barriers and procedures include: lack of coordinated procedures and data requirements for border crossing, border crossing infrastructure limitations, limited capacity in some inspection areas, business practices that unnecessarily create peak hours at border crossings, lack of government motivation to add needed personnel for 24-hour inspections, lack of leadership in the private sector and government to promote change for a more efficient border crossing system, and the different cultural environment between the two countries. These barriers add to the cost, congestion, delay, and pollution problems that already exist and prevent competition within the trucking industry (Haralambides and Londono-Kent 2004).

The trucking provisions of NAFTA have not yet been implemented, thus are many barriers that are causing excess time delays and costs for trucking firms. Inefficiencies at the border are causing unnecessary congestion and excess paperwork in order for trucking firms to transport the products traded between the U.S. and Mexico. As trade continues to increase between the two countries, the inefficiencies are becoming more problematic.

Summary

NAFTA was implemented in order to promote free trade that would benefit all three countries involved by eliminating tariffs and other trade barriers in order to make trade more beneficial and efficient. However, the non-tariff trade barriers that still exist in the trucking provisions are hindering these efforts. Although few studies have been done specifically related to the trucking industry, past studies done on regulation and deregulation have shown that fewer restrictions allow for more competition and thus forces trucking firms to be cost minimizing, which in return benefits the final consumer. Also, eliminating the barriers would solve the congestion; pollution; safety; and inefficiency problems. This study specifically looks at the trucking industry to determine if the impending implementation of the NAFTA trucking provisions will force firms to become more cost effective and efficient.

CHAPTER 3

METHODOLOGY AND MODELS

Trucking firms, by nature, are considered cost minimizing and can be analyzed by cost functions that describe the minimum cost of producing a certain level of output given the prices a firm must pay for factor inputs.

The purpose of this specific study is to determine what effects the announcement to begin implementing the NAFTA trucking provisions has had on costs for U.S. trucking firms. A translog cost function is used to analyze these effects. This method has been used in other studies. For example, Ying (1990a) used a translog cost function in order to analyze the productivity gains in the trucking industry following deregulation. McGeehan (1993) uses the translog cost function in order to determine changes in costs and productivity in the railroad industry in Ireland.

In this study, a translog cost function can be used to show the change in costs as a function of y (output quantities) and w (input prices) and other operating characteristics as shown below:

$$\ln C(y,w) = \alpha_0 + \sum_{m=1}^{3} \alpha_m \ln y_m + \sum_{i=1}^{5} \beta_i \ln w_i + \sum_{k=1}^{4} \rho_k A_k + \alpha_N N + \alpha_t T +$$
$$\tfrac{1}{2} \sum_m \sum_n \gamma_{mn} \ln y_m \ln y_n + \sum_m \sum_i \gamma_{im} \ln w_i \ln y_m + \sum_m \sum_k \gamma_m \ln y_{km} A_k +$$
$$\sum_m \gamma_{mn} \ln y_m N + \sum_m \gamma_{mT} \ln y_m T + \tfrac{1}{2} \sum_i \sum_j \gamma_{ij} \ln w_i \ln w_j + \sum_i \sum_k \gamma_{ik} \ln w_i A_k +$$
$$\sum_i \gamma_{iN} \ln w_i N + \sum_i \gamma_{iT} \ln w_i T + \tfrac{1}{2} \gamma_{TT} T^2 + \sum_k \gamma_{kT} A_k T + \sum_k \gamma_{KN} N A_k +$$
$$\sum_k \gamma_{kl} A_k A_l + \gamma_{NT} NT + \varepsilon, \qquad (1)$$

where C represents total operating costs; y represents three outputs: total intercity miles, total intercity tons, and total intercity shipments; w represents various input prices: average wage per worker, insurance costs per mile, equipment rental cost per mile, capital, and diesel price; A is operating characteristics: border state, outsourcing, and less-than-truckload; N is the NAFTA dummy variable; and T represents the time trend. This cost function is similar to the one used in Ying (1990a). The cost function is symmetric and homogeneous of degree one in prices, given y. This implies that

$$\sum \beta_i = 1 \tag{2}$$

and

$$\Sigma \gamma_{ik} = \Sigma \gamma_{kl} = \Sigma \gamma_{iy} = 0. \tag{3}$$

We could estimate equation (1) directly, but efficiency gains can be realized by estimating the cost-minimizing input demand functions transformed into cost share equations. Equation (1) can be logarithmically differentiated with respect to input prices, and by the Shephard's Lemma, we obtain cost equation of the following form

$$\partial \ln C \Big/ \partial \ln w_i = \frac{w_i X_i}{C} = S_i, \tag{4}$$

where S_i represents the cost share equation for each input. The translog cost function yields the cost share equations.

$$S_i = \alpha_i + \sum_m \alpha_m \ln y_m + \sum_j \gamma_{ij} \ln w_j + \sum_k \gamma_{ik} A_k + \gamma_{iN} N + \gamma_{it} T. \tag{5}$$

The cost share equations must equal the total cost

$$\sum_i^n w_i X_i = C, \tag{6}$$

and the sum of the cost shares must be equal to one:

$$\sum_i S_i = 1. \tag{7}$$

The cost function and factor share equations are jointly estimated by iterating Zellner's two-step procedure for estimating seemingly unrelated regressions. However, since the procedure requires the disturbances on the share equations to sum to zero for each firm, one of the cost share equations must be deleted from the system to obtain a nonsingular covariance matrix.

Allen partial elasticities of substitution can be computed from the cost function by the formula

$$\sigma_{ij} = CC_{ij} / \ C_i C_j, \tag{8}$$

where i and j represent partial differentiation of the cost function with respect to factor prices and

$$\sigma_{ij} = (\gamma_{ij} + S_i S_j) / \ S_i S_j, \tag{9}$$

$$\sigma_{ii} = (\gamma_{ii} + S_i^2 - S_i) / S_i^2, \ i \neq j$$

The Allen partial elasticities measure the change in quantity of the *i*th factor input in response to a change in the price of the *j*th factor. A positive sign indicates that the two inputs are substitutes and a negative sign indicates complements. Estimates of the input elasticities are evaluated at their sample means. The associated asymptotic standard errors are also computed using the following:

$$S.E. = S.E(\gamma_{ij}) / S_i S_j \tag{10}$$

$$S.E. = S.E.(\gamma_i^2) / S_i^2$$

The effect of NAFTA trucking provision implementation announcement on productivity can be measured by calculating the percentage change in costs due to a unit change in the NAFTA variable as follows

$$(C_1 - C_0)/C_0 \cdot 100 = \left[\exp\left(\alpha_N + \sum_m \gamma_{mN} \ln y_m + \sum_i \gamma_{iN} \ln w_{im} + \sum_k \gamma_{kN} A_k + \gamma_{NT} T \right) - 1 \right] 100 \quad (11)$$

In calculating equation 11, the variables are held at their means for years 4 and 5. The percentage change in costs is evaluated for 2002 and 2003 because the announcement that the process to begin implementing the NAFTA trucking provisions was made in 2002. Limiting the equation to 2002 and 2003 shows the effects the announcement has had on costs in the first years after it was discussed.

Equation (11) can be modified slightly to show the net effects the operating characteristic variables have had on total costs and can be written as follows,

$$(C_1 - C_0)/C_0 \cdot 100 = \left[\exp\left(\alpha_A + \sum_m \gamma_{mA} \ln y_m + \sum_i \gamma_{iA} \ln w_{im} + \gamma_{AN} N + \gamma_{AT} T - 1 \right) \right] 100 \quad (12)$$

Hypotheses

The underlying problem in this thesis is determining how the possible implementation of the NAFTA trucking provisions will economically affect the United States trucking industry. More specifically, we want to determine the effects the impending implementation has had on the total costs for trucking firms.

Trucking companies are assumed to be cost-minimizing in the long run. The long run cost minimizing function used will be *TC = TC (w, y, A, N),* where w represents the various input prices such as diesel fuel price; wages; insurance

premiums; rents of capital; and equipment, and y represents the output variables (intercity miles, intercity tons, and intercity shipments). N represents a dummy variable for the announcement of the implementation of NAFTA trucking provisions. The N variable is the primary test condition in this study. The variable A represents various operating characteristics as listed and include if the firm:

1. Is a border state to Mexico (Arizona, Texas, California, or New Mexico). Since these states lie right along the U.S./Mexico border, they may take a direct hit from the NAFTA implementations. They may experience more competition from Mexican firms than firms in other states.
2. Classifies itself as a less-than-truckload (LTL) carrier. A carrier is classified as a LTL carrier if the firm gets the majority of its revenue from loads of less than 10,000 pounds (Department of Transportation, FMCSA). LTL cargo often is consolidated and may require the use of a terminal network where freight is gathered, combined, loaded, moved, unloaded, sorted, loaded, and finally taken to its final destination, thus it might be expected that carrying LTL cargo may add to costs (Ying 1990a). Many other studies have used this operating characteristic in the research and these will be discussed later in this paper.
3. Outsources by hiring equipment and drivers. Firms are defined as outsourcing firms if they pay to rent equipment, drivers, or a combination of equipment and drivers. This characteristic is important to include because it may be more efficient for some firms to rent equipment or drivers rather than purchase new equipment or have drivers on staff full-time. Firms may also hire self-

employed drivers that own their own truck if extra labor is needed or to cut down on costs. Nickerson and Silverman (2003) found in their study that in the absence of externalities, many companies would prefer to contract with owner-operators because these types of drivers tend to take better care of their equipment and drive more safely than a driver using a company truck would. However, firms may prefer to hire drivers to drive company owned trucks when they need to coordinate the activities of their drivers more, as is the case of LTL carriers or when they invest more in their reputation.

Controlling for outputs and input prices, we wish to observe how the A and N variables affect total costs for trucking firms. We will make various hypotheses from this information. First we can look at how certain operating characteristics may affect total costs after the announcement regarding the NAFTA trucking provisions was made. If the trucking company is domiciled in a border state, we would expect a negative impact on costs. These companies stand the most risk of increased competition from Mexican firms, thus they will be forced to be more efficient to ward off the possible new competition. I would expect that LTL firms would have a positive impact on costs since these carriers require more terminal consolidation and stops for pickup and deliveries. I expect that firms that engage in outsourcing some of their work would have a negative impact on costs because a business generally outsources if it makes more economical sense than doing it themselves. Finally and most importantly, I expect the N variable to have a negative impact on a firm's total costs. The 2002 announcement that the U.S. would begin the process of implementing the trucking provisions of NAFTA would more than likely encourage

firms to become more cost effective in order to continue to be competitive if Mexican firms are allowed to begin operating in the U.S.

CHAPTER 4

DATA

Data used in this paper were obtained from the Class I and II Motor Carriers of Property and Household Goods Annual Report. The collection of for-hire trucking company financial and operating data is a mandatory program. All Class I and Class II motor carriers are required to submit Form M annually. Class I carriers must also file quarterly reports.[4] The data colle ction is managed by the Office of Motor Carrier Information (OMCI) of the Bureau of Transportation Statistics (BTS). Motor carrier data was used for the period of 1999-2003 for this study. This information was obtained from the BTS's Intermodal Transportation Database. Average regional diesel prices for each year were obtained from the Energy Information Administration (EIA). The EIA gives average diesel prices for eight regions which include: New England, Central Atlantic, Lower Atlantic, Midwest, Gulf Coast, Rocky Mountain, West Coast, and California.

Firms with missing data or data with obvious errors were dropped. Also, firms classified as specialty freight or household good carriers were dropped since these types of firms require specialized methods and procedures for carrying only specific goods and thus aren't necessarily comparable to general freight carriers. After making these omissions, the sample size is 3076. All dollar values were adjusted for inflation with 2000 as the base year. Descriptive statistics for all variables are listed in Table 1.

[4] Motor carriers of property are classified based on their adjusted annual operating revenue. Firms that have operating revenue greater than $10 million are classified as Class I, firms with revenue between $3-10 million are Class II, and those firms with revenues under $3 million are Class III.

Table 1. Descriptive Statistics

	Standard Deviation	Minimum Value	Maximum Value
Outputs (Y)			
Intercity miles	96000000	203000	1930000000
Intercity tons	64600000	1035	1450000000
Intercity shipments	11200000	164	573000000
Input Prices (w)			
Average Wage	11432	10700	98975
Insurance premium per mile	0.18	0.002	5.93
Equipment rent per mile	1.7	0.000009	72.58
Capital	33141	1112	883133
Diesel price	15.22	106.8	167.2
Characteristic variables (A)			
Border state	0.32	0	1
Less-than-truckload	0.38	0	1
Outsource	0.45	0	1
1999	0.39	0	1
2000	0.42	0	1
2001	0.42	0	1
2002	0.41	0	1
2003	0.36	0	1
NAFTA	0.48	0	1

Three different output variables were used: total intercity miles, total intercity tonnage, and total intercity shipments.[5] Total intercity miles is the amount of miles a firm logs each year, total intercity tonnage is the amount of goods carried each year measured in tons and total intercity shipments is the number of hauls a firm logs each year. Average total intercity mileage was at 24.5 million, average tonnage was about 8.7 million, and average number of intercity shipments was about 712,000.

Five different input prices were used: average wage, insurance premium per mile, equipment rent per mile, price of capital, and diesel price. Average wage was computed using the total wages paid to all employees (drivers, helpers, cargo

[5] Many past studies use revenue-ton-miles as output, however, data limitations did not make that feasible, thus the three outputs were used to effectively show output.

handlers, and administrative) divided by the number of employees. The average wage amounted to $43,126. The minimum wage was calculated at $10,700 which may seem low, however this can be attributed to part-time workers such as cargo handlers that earn lower wages, but are still accounted for in the total number of employees. The maximum wage is $98,976, which may seem rather high, however, it is important to note that the average wage is calculated using wages for all workers, including managers and other office workers. Further analysis of the wage data shows that only 1 percent of the firms' average wage is over $75,767.

Insurance premium per mile was calculated by taking total insurance expenses (cargo loss and damage premiums and claims paid, liability and property damage premiums and claims paid, and other insurance expenses) divided by total intercity miles. The equipment rent per mile value is composed of the sum of equipment rentals with drivers and equipment rentals without drivers divided by total intercity miles. Rental cost is important because many trucking firms choose to rent trucks or drivers or both if they don't have the capacity to handle all the shipments on their own or if it is less costly than owning their own.

Capital was measured by taking total operating expenses and subtracting total wage and salary expenses, total insurance expenses, total equipment rental expenses, and total fuel costs and dividing this amount by the average number of owned and leased equipment. Average fuel prices, measured in cents, for each year came from the yearly regional averages reported by the EIA. Since fuel prices vary across the

*country, each firm was assigned a price depending on which region the firm is domiciled in.[6]

Besides input and output variables, various dummy characteristic variables are used in this model. The border state dummy variable represents states that are adjacent to the U.S.-Mexico border. Firms based out of any of the border states (Texas, California, New Mexico, Arizona) are given a value of one, while the firms based out of other states are given a value of zero. The descriptive statistics indicate that about 11 percent of the firms used in this analysis are based in one of the four border states. This variable is important because firms in the border states may do a larger amount of transborder shipments because of their location and thus may be affected by NAFTA more than the other states.

Firms also characterize themselves based on the type of carriage that makes up the majority of their revenue. There are three different classifications firms can choose from: general freight, household goods, and specialty freight.[7] Only firms that classified themselves as general freight were used because firms classified as carriers of household goods or specialty freight are not comparable to general freight carriers since these types of firms require specialized methods and procedures for carrying only specific goods. General freight firms can classify themselves further as less-than-truckload (LTL) carriers, truckload carriers (TL), parcel carriers or container carriers. A dummy characteristic variable is used for LTL carriers, firms that classify

[6] Average fuel prices are given by eight different regions in the U.S. Since it was not feasible to obtained fuel price information for individual firms, the firm's fuel price is determined by location of the company headquarters. By doing so, I implicitly assume that, although firms may have nationwide networks, their operations tend to be more intense in their own domiciled regions.

[7] General freight is defined as miscellaneous commodities not requiring special handling or revenue equipment. Specialty freight is identified as freight requiring special handling and/or revenue equipment.

themselves as LTL are given a value of 1 and a value of 0 if they are classified as one of the other types. This characteristic is important because LTL carriers require more terminal consolidation and stops for pickup and deliveries.

The outsource characteristic variable indicates whether firms hire additional equipment and drivers in addition to their own equipment. This variable is significant as over 70 percent of the firms in this data set attribute some of their operating cost to hiring equipment and drivers from an outside source.

Nineteen percent of the data came from the 1999 annual reports, 23 percent from 2000, 22 percent from 2001, 21 percent from 2002, and 15 percent from 2003. This shows a fairly equitable distribution of data from each year. The NAFTA announcement variable has a mean of 0.36, which indicates that 36 percent of the firm data came from years 2002 and 2003. The announcement that the process to begin implementing the NAFTA trucking provisions was not formally announced until mid-2002, so 2002 and 2003 would be considered the first years when the announcement may have affected total costs (U.S. Department of Transportation 2002).

CHAPTER 5

RESULTS AND ANALYSIS

Translog Cost Estimates

The translog cost function and the four cost share equations were estimated jointly using the method of iterated maximum likelihood. The results from the translog cost function are shown in Table 2.

Table 2. Translog Cost Function Parameter Estimates

Observations	RMSE	R Squared	Chi Squared
3053	0.2859	0.9584	73577.39

Variable	Coefficient	Standard Error	t
Tons	-0.0498	0.0444	-1.12
Shipments	-0.1064	0.0543	-1.96
Miles	0.9623	0.0865	11.12
Labor	-1.9036	0.2807	-6.78
Diesel	0.558	0.2963	1.88
Equipment Rent	0.0089	0.0487	0.18
Capital	0.2546	0.0869	2.93
Outsource	0.3447	0.1899	1.82
Border State	0.4379	0.2274	1.93
Less-than-truckload	-0.5361	0.2081	-2.58
NAFTA	0.6498	0.3193	2.04
Time	-0.1451	0.1135	-1.28
Tons * Tons	-0.0046	0.001	-4.5
Tons * Shipments	-0.0058	0.0018	-3.25
Tons * Miles	0.0237	0.0044	5.4
Shipments * Shipments	-0.0134	0.0017	-7.84
Shipments * Miles	0.0564	0.0052	10.91
Miles * Miles	-0.0356	0.0052	-6.88
Tons * Labor	0.105	0.0058	1.81
Tons * Diesel	-0.0212	0.0066	-3.2
Tons * Equipment Rental	-0.0002	0.0012	-0.2
Tons * Capital	0.0001	0.0024	0.03
Shipments * Labor	0.0435	0.0072	6.07
Shipments * Diesel	-0.0757	0.0078	-9.66
Shipments * Equipment Rental	-0.0032	0.0014	-2.29
Shipments * Capital	-0.0046	0.0029	-1.61
Miles * Labor	-0.0464	0.0116	-4.01

Table 2. (continued)

Variable	Coefficient	Standard Error	t
Miles * Diesel	0.1004	0.013	7.72
Miles * Equipment Rental	-0.0057	0.0023	-2.51
Miles * Capital	-0.0133	0.0046	-2.91
Tons * Outsource	-0.0087	0.0042	-2.06
Tons * Border State	-0.0091	0.0046	-1.97
Tons * Less-than-truckload	0.0027	0.0047	0.57
Shipments * Outsource	0.0087	0.0056	1.54
Shipments * Border State	-0.0012	0.006	-0.2
Shipments * Less-than-truckload	0.0119	0.0059	2.03
Miles * Outsource	0.0026	0.0086	0.3
Miles * Border State	-0.0005	0.0097	-0.05
Miles * Less-than-truckload	-0.0258	0.0094	-2.75
Outsource * Border	-0.0233	0.0239	-0.97
Outsource * Less-than-truckload	-0.0699	0.02	-3.49
Border * Less-than-truckload	0.0413	0.0223	1.85
Tons * NAFTA	-0.0107	0.0072	-1.47
Shipments * NAFTA	-0.0249	0.0102	-2.44
Miles * NAFTA	0.0372	0.0134	2.78
Tons * Time	-0.0002	0.0026	-0.08
Shipments * Time	-0.003	0.0038	-0.79
Miles * Time	0.0036	0.0049	0.73
Labor * Labor	0.2612	0.039	6.69
Diesel * Diesel	0.1094	0.0559	1.96
Equipment Rental * Equipment Rental	0.0422	0.0014	30.4
Capital * Capital	0.022	0.0053	4.19
Labor * Diesel	-0.2758	0.0873	-3.16
Labor * Equipment Rental	0.0513	0.0127	3.95
Labor * Capital	-0.0223	0.022	-1.01
Diesel * Equipment Rental	-0.0267	0.015	-1.78
Diesel * Capital	0.0029	0.0269	0.11
Equipment Rental * Capital	-0.0086	0.0052	-1.66
Labor * Outsource	-0.0806	0.0265	-3.05
Labor * Border State	-0.0193	0.03	-0.64
Labor * Less-than-truckload	0.013	0.0288	0.45
Diesel * Outsource	0.0755	0.0314	2.4
Diesel * Border State	0.0222	0.0341	0.65
Diesel * Less-than-truckload	0.0735	0.0326	2.26
Equipment Rental * Outsource	0.0063	0.0046	1.35
Equipment Rental * Border State	0.0117	0.006	1.94
Equipment Rental * Less-than-truckload	0.0035	0.0053	0.65
Capital * Outsource	0.0015	0.0098	0.15
Capital * Border State	-0.0157	0.011	-1.43
Capital * Less-than-truckload	0.0225	0.0109	2.06

Table 2. (continued)

Variable	Coefficient	Standard Error	t
Labor * NAFTA	-0.0025	0.0411	-0.06
Diesel * NAFTA	-0.0331	0.0479	-0.69
Equipment Rental * NAFTA	0.0205	0.0073	2.82
Capital * NAFTA	-0.0201	0.0148	-1.36
Labor * Time	0.0122	0.0151	0.81
Diesel * Time	-0.0285	0.0174	-1.63
Equipment Rental * Time	-0.0023	0.0027	-0.84
Capital * Time	0.003	0.0055	0.54
Time * Time	0.0243	0.0079	3.09
NAFTA	-0.1039	0.0398	-2.61
Outsource * Time	0.0031	0.0104	0.3
Border State * Time	-0.01	0.0127	-0.79
Less-than-truckload * Time	-0.0171	0.0133	-1.28
Outsource * NAFTA	-0.0223	0.0283	-0.79
Border State * NAFTA	0.0079	0.0346	0.23
Less-than-truckload * NAFTA	0.0602	0.0344	1.75
Intercept	11.3442	1.2541	9.05

The total intercity miles variable has a positive coefficient value which indicates a positive impact on costs; the more miles a firm logs, the higher their costs will be. The cost elasticity of intercity miles is 0.946, suggesting that a 1 percent increase in output causes total cost to rise 0.946 percent, *ceteris paribus*. The total intercity shipment coefficient is negative and significant, meaning carrying more shipments decreases costs, which is opposite of what might be expected. Also, the cost elasticity of the total intercity tons variable has a small negative value, indicating that neither of the latter two output variables contributes significantly to total costs. The total intercity tonnage and total intercity shipment variables are not significant. The fact that intercity was the only significant output variable may indicate that it makes up the majority of the costs.

Three of the input price variables prove to be significant in this model. The capital price variable is highly significant and positive. The coefficient for capital indicates that one percent increase in capital expenditures causes total costs to increase by .29 percent. The labor input variable is also significant, but with a negative value. The diesel coefficient indicates that a once percent increase in diesel expenditures causes total costs to increase by .558 percent. The equipment rental cost per mile variable has a small positive coefficient value, but is not significant in the model. The cost elasticities of the input variables indicate that capital contributes the most to total costs.

The NAFTA variable is significant at the 5 percent level. All three of the characteristic variables are significant in the model. The effects of these variables on total costs will be discussed later in the paper.

Direct Effects of Time on Costs

In this translog cost function, a time variable is included to capture the unobserved factors over time after controlling for various firms' characteristics and the effect of NAFTA announcement. direct effects of time on total costs are calculated and shown in Table 3.

The results posted in Table 3 indicate that total costs were indeed decreasing from 1999 to 2001 but at a diminishing rate. Costs were reduced by 13.83 percent in 1999 and this had decreased to 13.22 percent in 2001. The main variable that attributed to the cost decrease in addition to time was the diesel variable. This is somewhat speculative given the fact that diesel prices actually increased during that time period, however, it is important to note that neither the diesel variable nor any of

the other input variable interaction terms with time are significant. In 2002, the in which the NAFTA announcement was made, costs decreased by 22.08 percent. In 2003 costs decreased by 21.37 percent. In addition to just the time variable decreasing costs, the NAFTA variable also contributed greatly to the reduced costs and this interaction term is significant. The fact that costs are decreasing at a diminishing rate could indicate that the effect of NAFTA on costs will eventually disappear after the industry has fully adjusted.

The border state and LTL characteristic variables carry negative signs which indicate that they have added to cost savings over time. The outsource variable is positive indicating that it has added to costs over time, however, all of these interaction terms also prove to be insignificant at the 10 percent level.

Table 3. Percentage Change in Costs Due to Time

Year	Time	Time* Tons	Time* Shipment	Time* Miles	Time* Labor	Time* Diesel	Time* Rent
1999	-0.1451	-0.0002	-0.003	0.0036	0.0233	-0.0285	-0.0023
2000	-0.1451	-0.0004	-0.006	0.0072	0.0244	-0.057	-0.0046
2001	-0.1451	-0.0006	-0.009	0.0108	0.0366	-0.0855	-0.0069
2002	-0.1451	-0.0008	-0.012	0.0144	0.0488	-0.114	-0.0092
2003	-0.1451	-0.001	-0.015	0.018	0.061	-0.1425	-0.0115

Year	Time* Capital	Time* OUT	Time* BOR	Time* LTL	Time* Time	Time* NAFTA	percent Change Total C
1999	0.003	0.0031	-0.01	-0.0171	0.0243	0	-13.83
2000	0.006	0.0031	-0.01	-0.0171	0.0486	0	-14.01
2001	0.009	0.0031	-0.01	-0.0171	0.0729	0	-13.22
2002	0.012	0.0031	-0.01	-0.0171	0.0972	-0.1168	-22.08
2003	0.015	0.0031	-0.01	-0.0171	0.1215	-0.1168	-21.37

Direct Effects of NAFTA Variable on Costs

The NAFTA variable has a positive coefficient variable and is statistically significant. This is alarming at first glance, being the hypothesis of this study was that

the NAFTA variable would reduce costs over time, but we must calculate the total effect of NAFTA on costs. To accomplish this, we must use equation (11) to calculate the percentage change in cost due to NAFTA. The direct effect is evaluated at the sample means of the data for continuous variables for the years 2002 and 2003, and at a discrete change from 0 to 1 for binary variables. It was noted earlier that this analysis is only done for the years 2002 and 2003 because the announcement that steps would be taken to begin implementing the trucking provisions of NAFTA was made in 2002. The results are listed in Table 4.

Table 4. Percentage Change in Cost Due to NAFTA

Year	N	N*Tons	N*Ship	N*Miles	N*Labor	N*Diesel	N*Rent
2002	0.6498	-0.1358	-0.2552	0.5903	-0.0266	-0.1636	-0.0358
2003	0.6498	-0.1339	-0.2545	0.5902	-0.0266	-0.1664	-0.0379

Year	N*Capital	N*OUT	N*BOR	N*LTL	N*T	percent Change Total C
2002	-0.1895	-0.0223	0.0079	0.0602	-0.4156	6.59
2003	-0.1894	-0.0223	0.0079	0.0602	-0.5195	-4.16

The first order parameter estimate for the NAFTA variable as computed in the translog cost function was a value of .6498, which would indicate that the cost elasticity of NAFTA has increased over time. However it is important to isolate the NAFTA variable and to calculate the percentage change in costs due to a unit change in the NAFTA variable. The results of equation (12) indicate that the NAFTA variable had a 6.59 percent increase on total costs in the first year after the announcement to begin steps to implement the NAFTA trucking provisions was made known. In 2003, the NAFTA variable caused costs to decrease by 4.16 percent. The fact that costs actually increased in 2002 could be because it took time for the industry to adjust. The results in Table 4 also show that the time and NAFTA interaction term and the

capital and NAFTA interaction term are contributing the most to the outcome of the percentage change calculation. Only the equipment rental interaction term is significant.

The results of the percentage change in costs due to NAFTA are quite consistent with results of other similar studies. Ying (1990a) used a similar translog cost function to determine the effects deregulation had on costs in the trucking industry. His results show an increase in costs of about 7.25 percent in the first year after deregulation, but show cost savings of 1.1 percent in the second year. By the fifth year after deregulation, in 1984, costs were decreased by nearly 23 percent. The slight increase in costs in the first year can be attributed to taking time for the industry to adjust. Since the trucking provisions of NAFTA have not been fully implemented, the industry hasn't necessarily had to completely adjust, only prepare for the changes that may come when the NAFTA trucking provisions are being fully carried out.

Blair *et al.* (1986) looked at the effects motor carrier deregulation had on the state of Florida. This study found that the removal of state regulatory constraints on the trucking industry had a 14 percent decrease in rates, which can be directly related to a decrease on operating costs. The paper also concluded that removing restrictions on the trucking industry resulted in efficiency improvements which reduced costs of providing trucking services.

The negative sign on the interaction terms involving NAFTA and the outsource characteristic variable indicates that more outsourcing helps to reduce costs, however, this term is insignificant. The interaction terms involving the LTL and border characteristic variables have a positive sign indicating that having more LTL traffic

and traveling in border states adds to costs over time. Only the LTL interaction term is significant.

Direct Effects of Input Price Variables on Costs

It is important to examine how the input price variables have affected total costs since the NAFTA announcement. The first input price analyzed was the labor wage. The results are shown in Table 5.

Table 5. Percentage Change in Costs Due to Labor Costs

Year	Labor	Labor* Tons	Labor* Shipments	Labor* Miles	Labor* Labor	Labor* Diesel	Labor* Rent
1999	-1.9036	1.3495	0.4512	-0.7366	2.7751	-1.3033	-0.0987
2000	-1.9036	1.3323	0.4647	-0.7342	2.7793	-1.3821	-0.0957
2001	-1.9036	1.3257	0.4448	-0.7315	2.7777	-1.3654	-0.0901
2002	-1.9036	1.3137	0.4459	-0.7315	2.7822	-1.3635	-0.0896
2003	-1.9036	1.3137	0.4447	-0.7361	2.7796	-1.3862	-0.0949

Year	Labor* Capital	Labor* OUT	Labor* BOR	Labor* LTL	Labor* T	Labor* N	% Change Total C
1999	-0.2099	-0.0806	-0.0193	0.013	0.0122	0	0.249
2000	-0.2099	-0.0806	-0.0193	0.013	0.0244	0	0.1883
2001	-0.2092	-0.0806	-0.0193	0.013	0.0366	0	0.1981
2002	-0.2092	-0.0806	-0.0193	0.013	0.0488	-0.0025	0.2038
2003	-0.2091	-0.0806	-0.0193	0.013	0.061	-0.0025	0.1797

Note: The direct effect is evaluated at the sample means of the data for continuous variables for each year and at a discrete change from 0 to 1 for binary variables.

In general, we expect labor costs to continue to increase over time, and from 1999-2003, we see that labor costs are increasing, but at a decreasing rate. Labor wages increased total costs by 0.249 percent in 1999 and by 0.180 percent in 2003, the lowest increase in the five year period. It is important to note that the increase is less in 2003 than in 2002, which could indicate that labor costs wages, are decreasing after the NAFTA announcement. But it is also important to note that this trend actually started in 1999 which could indicate that there are other factors that have caused labor costs to rise but at a lower rate since 1999.

The diesel fuel price has an unexpected negative effect on costs, as the results in Table 6 indicate. It is somewhat surprising that diesel price has had a negative impact on costs given that the trend has been that diesel prices increased during these years. The results of Table 6 appear to be implausible and could be due to the regional diesel price values used in the model. The firms were assigned a yearly average diesel price depending on where the firm is domiciled, however it is known that firm's trucks may travel out of the home area and thus the assigned diesel price may not best represent a firm's diesel price. This discrepancy in diesel prices may have created the unexpected negative net effects.

Table 6. Percentage Change in Cost Due to Diesel Price

Year	Diesel	Diesel* Tons	Diesel* Shipments	Diesel* Miles	Diesel* Labor	Diesel* Diesel	Diesel* Rent
1999	0.558	-0.2725	-0.7852	1.5938	-2.9302	0.517	0.0514
2000	0.558	-0.269	-0.8087	1.5886	-2.9346	0.5482	0.0498
2001	0.558	-0.2677	-0.774	1.5828	-2.933	0.5416	0.0469
2002	0.558	-0.269	-0.7759	1.5933	-2.9377	0.5409	0.0466
2003	0.558	-0.2652	-0.7739	1.5929	-2.935	0.5499	0.0494

Year	Diesel* Capital	Diesel* OUT	Diesel* BOR	Diesel* LTL	Diesel* T	Diesel* N	% Change Total C
1999	0.0273	0.0755	-0.0222	0.0735	-0.0285	0	-1.1421
2000	0.0273	0.0755	-0.0222	0.0735	-0.057	0	-1.1707
2001	0.0272	0.0755	-0.0222	0.0735	-0.0855	0	-1.1768
2002	-0.0272	0.0755	-0.0222	0.0735	-0.114	-0.0331	-1.2913
2003	-0.0272	0.0755	-0.0222	0.0735	-0.1425	-0.0331	-1.2999

Note: The direct effect is evaluated at the sample means of the data for continuous variables for each year, and at a discrete change from 0 to 1 for binary variables.

Table 7 shows the direct effect of the equipment/driver rental variable on total costs. The rental cost has had a positive impact on costs since 1999 which was fairly steady until 2001. After the NAFTA announcement, the positive effect of the equipment rental variable increased slightly. In 1999 the variable had a positive 0.159 percent impact on total costs and this increased to 0.1766 percent in 2002. This

indicates that firms are spending more on renting equipment and hiring owner-operators. Equipment and driver rents have a positive impact on firms' costs.

Table 7. Percentage Change in Costs Due to Equipment and Driver Rents

Year	Rent	Rent* Tons	Rent* Shipments	Rent* Miles	Rent* Labor	Rent* Diesel	Rent* Rent
1999	0.0089	-0.0026	-0.0332	-0.0905	0.545	-0.1262	-0.0812
2000	0.0089	-0.0025	-0.0342	-0.0902	0.5459	-0.1338	-0.0787
2001	0.0089	-0.0025	-0.0327	-0.0899	0.5455	-0.1322	-0.0741
2002	0.0089	-0.0025	-0.0328	-0.0905	0.5464	-0.132	-0.0737
2003	0.0089	-0.0025	-0.0327	-0.0904	0.5459	-0.1342	-0.0781

Year	Rent* Capital	Rent* OUT	Rent* BOR	Rent* LTL	Rent* T	Rent* N	% Change Total C
1999	-0.0809	0.0063	0.0117	0.0035	-0.0023	0	0.1586
2000	-0.0809	0.0063	0.0117	0.0035	-0.0046	0	0.1513
2001	-0.0807	0.0063	0.0117	0.0035	-0.0069	0	0.157
2002	-0.0807	0.0063	0.0117	0.0035	-0.0092	0.0205	0.1759
2003	-0.0807	0.0063	0.0117	0.0035	-0.0115	0.0205	0.1667

Note: The direct effect is evaluated at the sample means of the data for continuous variables for each year, and at a discrete change from 0 to 1 for binary variables.

The results of the capital input price variable on total costs are shown in Table 8. The capital price variable has a very small and almost negligible impact on costs from 1999-2001. In 2002 and 2003 this impact becomes a very small negative impact. This may be due to the fact that increases in capital expenditure enhance firms' operations and thereby lower firms' production costs. For example Hubbard (1993) found that firms that increased their usage of high tech devices have greatly improved efficiency. Firms may be finding that investing in technologically advanced equipment greatly increases efficiency and thus reduces costs. It may also be assumed that investing in newer, more fuel efficient trucks would reduce costs as well. Thus investment in higher technology capital reduces costs, but by a small degree.

Table. 8 Percentage Change in Costs Due to Capital Costs

Year	Capital	Capital* Tons	Capital* Shipments	Capital* Miles	Capital* Labor	Capital* Diesel	Capital* Rent
1999	0.2546	0.0013	-0.0477	-0.2111	-0.2369	0.0137	0.0166
2000	0.2546	0.0013	-0.0491	-0.2104	-0.2373	0.0145	0.016
2001	0.2546	0.0013	-0.047	-0.2097	-0.2371	0.0144	0.0151
2002	0.2546	0.0013	-0.0471	-0.2111	-0.2482	0.0143	0.015
2003	0.2546	0.0013	-0.047	-0.211	-0.2373	0.0146	0.0159

Year	Capital* Capital	Capital* OUT	Capital* BOR	Capital* LTL	Capital* T	Capital* N	% Change Total C
1999	0.207	0.0015	-0.0157	0.0225	0.003	0	0.0074
2000	0.2071	0.0015	-0.0157	0.0225	0.006	0	0.0097
2001	0.2064	0.0015	-0.0157	0.0225	0.009	0	0.0139
2002	0.2064	0.0015	-0.0157	0.0225	0.012	-0.0201	-0.0159
2003	0.2063	0.0015	-0.0157	0.0225	0.015	-0.0201	-0.0007

Note: The direct effect is evaluated at the sample means of the data for continuous variables for each year, and at a discrete change from 0 to 1 for binary variables.

Direct Effects of Operating Characteristic Variables on Costs

It is also important to look at how each of the operating characteristic variables have affected costs since the NAFTA announcement. The translog cost function results indicate the less-than-truckload variable is highly negative and statistically significant. This variable carries a large negative coefficient indicating that firms that derived their revenue from less-than-truckload traffic had lower costs. Percentage change in costs due to the LTL variable was calculated using equation (12) and the results are displayed in Table 9.

The less-than-truckload (LTL) operating characteristic variable had an overall decrease on total costs ranging from 11.228 percent to 14.782, with no noticeably difference after the NAFTA announcement. It is important to note that the interaction term between time and the LTL variable had a negative impact on costs. Also, the interaction term between LTL and outsource has a very significant, negative coefficient indicating that LTL firms that outsource help to reduce total costs. These

results are somewhat surprising given the fact that LTL hauls are not full truckloads and require more consolidation. However, previous research has found the same result in regard to effects of the less-than-truckload variable on costs. For example Ying (1990a) analyzed what effects have contributed to decreased costs following deregulation. He found that prior to deregulation, a higher percentage of LTL traffic added to costs, but in the years following deregulation, this characteristic helped reduce total costs. This could possibly indicate that removing some of the restrictions on the trucking industry has made LTL hauls more efficient. Another study done by the Upper Great Plains Transportation Institute (1997) found that the LTL sector is becoming more consolidated. Many of the larger LTL firms also own some of the smaller LTL firms which give them a cost advantage in consolidated loads and having resources and facilities for getting consolidation done more efficiently.

Table 9. Percentage Change in Cost Due to LTL

Year	LTL	LTL* Tons	LTL* Shipments	LTL* Miles	LTL* Labor	LTL* Diesel	
1999	-0.5361	0.0347	0.1234	-0.4096	0.1381	0.3473	
2000	-0.5361	0.0343	0.1271	-0.4082	0.1383	0.3683	
2001	-0.5361	0.0341	0.1217	-0.4067	0.1382	0.3639	
2002	-0.5361	0.0343	0.122	-0.4094	0.1385	0.3634	
2003	-0.5361	0.0338	0.1217	-0.4093	0.1383	0.3694	
Year	LTL* Rent	LTL* Capital	LTL*T	LTL*N	LTL* BOR	LTL* OUT	% Change Total C
1999	-0.0067	0.2117	-0.0171	0	0.0413	-0.0699	-13.3055
2000	-0.0065	0.2118	-0.0342	0	0.0413	-0.0699	-12.526
2001	-0.0061	0.2111	-0.0513	0	0.0413	-0.0699	-14.7817
2002	-0.0061	0.2111	-0.0684	0.0602	0.0413	-0.0699	-11.2281
2003	-0.0065	0.211	-0.0855	0.0602	0.0413	-0.0699	-12.3308

Note: The direct effect is evaluated at the sample means of the data for continuous variables for each year and at a discrete change from 0 to 1 for binary variables.

The negative effect on costs may also be attributed to the fact that the goods are being shipped at a faster rate because firms are waiting for goods to come before

sending the shipment off, thus more trucks are available and not sitting empty waiting. Hubbard (1993) stressed the importance that technological advancements such as on board computers and electronic vehicle management systems have had on improving network conditions. The improved technology allows better communication between the dispatcher and driver and allows the dispatcher to track the driver's exact location in order to keep the drivers on the road and loaded more often. The negative impact on total costs indicates it is efficient for firms to handle less-than-truckload shipments.

The translog cost function results show that the outsource characteristic variable carries a positive sign, and it is significant at the ten percent level. The coefficient indicates that firms that outsource have costs that are about .345 percent higher than firms that do not outsource. However, it is important to look at the direct effects of outsourcing on costs over time. To accomplish this, equation (12) is used and the results are shown in Table 10.

Although it was noted that firms that outsource have costs that are about .345 percent higher than firms that do not outsource, the direct impacts of outsourcing indicate that this method actually helps reduce total costs. The outsource operating characteristic variable also indicates a negative impact on total costs which is what the original hypothesis of this study predicted. This negative impact on costs again indicates that outsourcing adds to the efficiency of a trucking firm. The negative effects of outsourcing on total costs range from 17.757 to 20.053 percent. As with the LTL variable, there are no noticeable changes in the effect of the outsource variable after the NAFTA announcement, possibly indicating that there are other variables causing the negative effect or it is the general nature of the firm to do so. The

outsourcing variable indicates that a firm hires either equipment or drivers or a combination of both to do work for them. It may be more cost effective for a firm to rent equipment rather than buying additional equipment or might be less costly to hire workers especially if it reduces costs such as health insurance and other fringe benefits.

Table 10. Percentage Change in Cost Due to Outsourcing

Year	OUT	OUT* Tons	OUT* Shipments	OUT* Miles	OUT* Labor	OUT* Diesel	
1999	0.3447	-0.1118	0.0902	0.0413	-0.8563	0.3568	
2000	0.3447	-0.1104	0.0929	0.0411	-0.8576	0.3784	
2001	0.3447	-0.1098	0.089	0.041	-0.8571	0.3738	
2002	0.3447	-0.1104	0.0892	0.0413	-0.8585	0.3733	
2003	0.3447	-0.1089	0.0889	0.0412	-0.8577	0.3795	
Year	OUT* Rent	OUT* Capital	Out*T	OUT*N	OUT* BOR	OUT* LTL	% Change Total C
1999	-0.0121	0.0141	0.0031	0	-0.0233	-0.0699	-20.0101
2000	-0.0117	0.0141	0.0062	0	-0.0233	-0.0699	-17.7571
2001	-0.0111	0.0141	0.0093	0	-0.0233	-0.0699	-18.0818
2002	-0.011	0.0141	0.0124	-0.0223	-0.0233	-0.0699	-19.7915
2003	-0.0117	0.0141	0.0155	-0.0223	-0.0233	-0.0699	-20.0528

Note: The direct effect is evaluated at the sample means of the data for continuous variables for each year and at a discrete change from 0 to 1 for binary variables.

Nickerson and Silverman (2003) indicate that it is often times more desirable for a trucking company to hire owner-operators rather than to keep company vehicles because those drivers maintain their trucks better and drive more safely. It is more efficient for firms to own their own trucks and have their own drivers on staff if they carry a large portion of LTL traffic. However, the significant negative interaction term between the outsource and LTL variables indicates the opposite. It shows that LTL firms that outsource have lower costs.

The final variable analyzed is the border state characteristic variable. The border state variable is not significant, possibly reflecting the lower percentage of

firms that are in border states versus those that are not. Again, equation (13) was used to analyze the variable's effect on costs and results are listed in Table 11. The border state characteristic variable is the only variable that has had a positive impact on costs, however, it is rather small and has decreased from 1999-2003. Although it is difficult to determine where exactly trucking firms do most of their business, the results appear to suggest that, holding other factors constant, firms domiciled in US-Mexico border states tended to incur higher costs, but these firms incurred smaller costs each year.

Table 11. Percentage Change in Cost Due to the Border State Variable

Year	BOR	BOR* Tons	BOR* Shipments	BOR* Miles	BOR* Labor	BOR* Diesel	
1999	0.4379	-0.117	-0.0124	-0.0079	-0.2051	0.1049	
2000	0.4379	-0.1155	-0.0128	-0.0079	-0.2054	0.1113	
2001	0.4379	-0.1149	-0.0123	-0.0079	-0.2052	0.1099	
2002	0.4379	-0.1155	-0.0123	-0.0079	-0.2056	0.1098	
2003	0.4379	-0.1139	-0.0123	-0.0079	-0.2054	0.1116	
Year	BOR* Rent	BOR* Capital	BOR*T	BOR*N	BOR* LTL	BOR* OUT	% Change Total C
1999	-0.0225	-0.1478	-0.01	0	0.0413	-0.0233	3.8877
2000	-0.0218	-0.1478	-0.02	0	0.0413	-0.0233	3.6672
2001	-0.0205	-0.1473	-0.03	0	0.0413	-0.0233	2.8092
2002	-0.0204	-0.1473	-0.04	0.0079	0.0413	-0.0233	2.4905
2003	-0.0216	-0.1472	-0.05	0.0079	0.0413	-0.0233	1.7247

Note: The direct effect is evaluated at the sample means of the data for continuous variables for each year and at a discrete change from 0 to 1 for binary variables.

Allen Partial Elasticities of Substitution

The cost share equations were estimated along with the translog cost function and those results are listed in Table 13 in the Appendix. Using those estimates, we can use equation (10) to find the Allen partial elasticities of substitution. It should be noted that the elasticities of substitution were computed at their sample means. The elasticity values are recorded in Table 12. The asymptotic standard errors were also calculated and shown in Table 12 in italics.

Table 12. Allen Partial Elasticities of Substitution

	Labor	Diesel	Equip. Rent	Capital
Labor	**-1.0625**	**0.947**	**0.5532**	**0.0503**
	0.004	*-0.0094*	*-0.0006*	*-0.0013*
Diesel		**-2.8119**	**0.353**	**0.5853**
		0.018	*-0.0004*	*-0.0005*
Equip. Rent			**-1.9459**	**0.468**
			0.0027	*-0.0018*
Capital				**-1.4873**
				0.0031

The own price elasticities have the expected negative sign and the cross price elasticities among the price inputs are all positive which indicate that they are substitutes. The positive sign of the cross price elasticities indicates that an increase in the price of one of these inputs will cause the firm to turn to other less costly inputs. The elasticity of substitution between labor and diesel is quite large at 0.947, this indicates that if there is a 1 percent increase in the price of one of these inputs, then the firm will increase their demand for the other input by 0.947 percent. The elasticity of substitution between labor and capital has a much smaller value. Its value of 0.05 indicates that as the price of either labor or capital increases by 1 percent, the demand for the other input only increases by 0.05 percent.

CHAPTER 6

SUMMARY AND CONCLUSIONS

The main purpose of this study was to determine how U.S. trucking firms have reacted to the U.S.'s pledge to begin the process of implementing the trucking provisions of NAFTA regarding U.S. and Mexican transborder trucking. In 2001, legislation was passed that detailed 22 safety requirements that had to be met before allowing trucks from Mexico to drive beyond U.S. commercial zones. The Transportation and Related Agencies Appropriations Act of 2002 included a section that allotted funds to carry out these safety requirements. In 2002 the U.S. Department of Transportation confirmed that all these requirements were being met and the U.S. would be prepared to open the border to Mexican-domiciled commercial vehicles by mid-2002. The border was not completely open in 2002 because of litigation that continued to delay full implementation. However, the message was clear: the process to open the borders had begun.

As mentioned in the literature review, there was much opposition and concern over the process of deregulation because some firms feared the increased competition among carriers would have negative impacts. However, nearly all of these studies found that deregulation and the subsequent increased competition forced trucking firms to become more efficient and innovative to remain competitive. There has been similar hype in the trucking industry dealing with the trucking provisions of NAFTA which would allow Mexican trucks to travel anywhere in the U.S. and also allow U.S. trucks to travel within Mexico. Much of the opposition was justified by safety concerns, but many U.S. firms worried about increased competition from the Mexican

firms. Like deregulation, it would be necessary for U.S. firms to become more cost effective and efficient in order to remain competitive once the NAFTA trucking provisions were fully carried out.

The original hypothesis of this paper was that trucking firms' total costs would decrease as a result of the impending border opening due to NAFTA in the near future. The results confirm this hypothesis. It was found that in 2002, the year in which is was announced steps would be taken to implement the transborder trucking provisions, U.S. trucking firms' costs increased by 6.59 percent in the first year but decreased by 4.19 percent in the second year. The increase in the first year could be due to adjustment time in the industry, but by the second year firms are taking steps to reduce costs before the trucking provisions are fully implemented.

It was also found that outsourcing and LTL have continued to have negative impact and there were no noticeably changes after the NAFTA announcement. The results also show that firms domiciled in border states tend to have higher costs than other firms. However, it is important to note that these costs have become smaller each year since 1999.

In regards to the input price variables, the diesel and capital variables had a negative impact on total costs, however it was noted earlier that the effects of diesel price were implausible. The capital price variable had very small negative impacts total costs after 2002, which could indicate that investment in new capital is more cost effective. The equipment rental and labor input price variables were positive. This could be attributed to the fact that outsourcing has become cost savings tool in the industry, thus more firms are directing funds to this expenditure. Also, price of labor

in general tend to increase from year to year due to salary increases, especially if the firm is expanding.

This research gives us an understanding of how trucking firms are preparing themselves for the implementation of the trucking provisions. Data at the time of this study only included up to the year 2003, but further studies in the future could use subsequent years' trucking data to determine if the trend among trucking firms to increase efficiencies to remain competitive still exits. Also, after the NAFTA trucking provisions are fully implemented, it would be interesting to see how the full implementation has affected trucking firms in both the U.S. and Mexico. The threat of implementing the trucking provisions caused firms total costs to decrease in 2003, ceteris paribus, so it would be interesting to see if this trend continues in subsequent years,

NAFTA may further help U.S. trucking firms become more efficient. It would allow them to travel to their final destination when hauling goods to Mexico. They would not have to incur the extra time and costs to unload the goods at the border, store them, and reload on a Mexican truck. It would more than likely be more efficient to have direct access to their final destination in Mexico.

Since the legislation in 2002 that would subsequently allow the process of implementing the trucking provisions of NAFTA was announced, the process of actual implementation has been somewhat of a sluggish one. There was litigation in 2002 to bar the implementation of NAFTA's trucking provisions in which the U.S. Ninth Circuit Court of Appeals ruled in favor of. However, in 2004, the U.S. Supreme Court unanimously reversed that decision and the U.S. Department of

Transportation has been working to develop a NAFTA trucking pilot program.

Nearly 14 years after NAFTA was signed into effect, a pilot program to allow 100 different Mexican carriers into the U.S. and 100 U.S. carriers into Mexico is being proposed to test out the NAFTA provisions. There is still opposition, but only time will tell how the NAFTA provisions will work out for both countries. Research has show that past reforms in the trucking industry have forced trucking firms to become more efficient benefiting both the business and the consumer. Further research may be able to give us the answer if the actual implementation of the NAFTA trucking provisions will have the same effect.

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APPENDIX

Table 13. Cost Share Equations

Equation	Observations	RMSE	R Squared	Chi Squared
Labor	3053	0.1064	0.517	3292.87
Diesel	3053	0.0523	0.3455	1623.63
Equipment Rental	3053	0.1345	0.6048	4707.21
Capital	3053	0.0883	0.5026	2108.13
Variable	Coefficient	Standard Error	t	
Labor				
Tons	-0.0012	0.0012	-1.05	
Shipments	0.0219	0.0014	15.28	
Miles	-0.0174	0.0022	-7.85	
Labor	0.102	0.0069	14.7	
Diesel	-0.0689	0.0076	-8.67	
Equipment Rental	-0.0352	0.0013	-28.04	
Capital	-0.0477	0.0026	-18.28	
Outsource	-0.0348	0.005	-6.98	
Border	-0.007	0.0061	-1.16	
Less-than-Truckload	0.0625	0.0056	11.21	
NAFTA	-0.0049	0.0077	-0.63	
Time	-0.0041	0.0028	-1.44	
Intercept	0.2409	0.0504	4.78	
Diesel				
Tons	0.0005	0.0006	0.91	
Shipments	-0.0116	0.0007	-16.24	
Miles	0.0095	0.0011	8.62	
Labor	-0.0338	0.0035	-9.79	
Diesel	0.062	0.004	15.67	
Equipment Rental	-0.016	0.0006	-25.62	
Capital	-0.0124	0.0013	-9.56	
Outsource	0.0033	0.0025	1.33	
Border	-0.0069	0.003	-2.29	
Less-than-Truckload	-0.0235	0.0028	-8.47	
NAFTA	-0.011	0.0038	-2.86	
Time	0.0013	0.0014	0.91	
Intercept	0.2238	0.0251	8.91	
Equipment Rental				
Tons	-0.0002	0.0015	-0.1	
Shipments	-0.0053	0.0018	-2.9	
Miles	0.0033	0.0028	1.19	
Labor	-0.0098	0.0088	-1.11	
Diesel	0.0414	0.01	4.1	
Equipment Rental	0.0776	0.0016	48.69	
Capital	-0.0294	0.0033	-8.89	

Table 13. Continued

Variable	Coefficient	Standard Error	t
Equipment Rental			
Outsource	0.0407	0.0063	6.43
Less-than-Truckload	-0.0201	0.0071	-2.84
Time	0.0029	0.0036	0.8
Intercept	0.274	0.064	4.28
Capital			
Tons	0.0011	0.001	1.1
Shipments	-0.0019	0.0012	-1.63
Miles	0.0006	0.0018	0.3
Labor	-0.0469	0.0058	-8.09
Diesel	-0.0348	0.0066	-5.24
Equipment Rental	-0.0242	0.001	-23.1
Capital	0.0936	0.0022	42.99
Outsource	-0.0112	0.0042	-2.88
Border	0.0075	0.0051	1.48
Less-than-Truckload	-0.013	0.0047	-2.79
NAFTA	-0.008	0.0064	-1.25
Time	-0.0019	0.0024	-0.82
Intercept	0.0523	0.0421	1.24